



**NDIA System Engineering Division**

**Integrated Diagnostics Committee**

**Electronics Prognostics Technology**

**Task Group**

**E-Prog II Workshop**

**Electronics Prognostics R&D Needs Definition**

**24 - 25 January 2006**

# **E-Prog Workshop I Background**

## **JSF Assigned Task**

- **Define diagnostics data needed to implement electronics prognostics**

## **Conclusions:**

- **The need for electronic system prognostic capability is prominent in many new weapon systems.**
- **Electronic System prognostics cannot be fielded now. ... Additional R&D and V&V efforts are needed.**

## **Recommended Follow-on Actions:**

- **Define and prioritize the R&D and V&V tasks required to establish a fieldable electronic system prognostic capability..**
- **Generate a program roadmap for planning, sequencing and funding these tasks. Establish funding sources, transition paths and sponsors and implement the Electronic System Prognostic - Implementation Initiative (ESP-I<sup>2</sup>).**

## **DoD Instruction 5000.2 Statement on Prognostics**

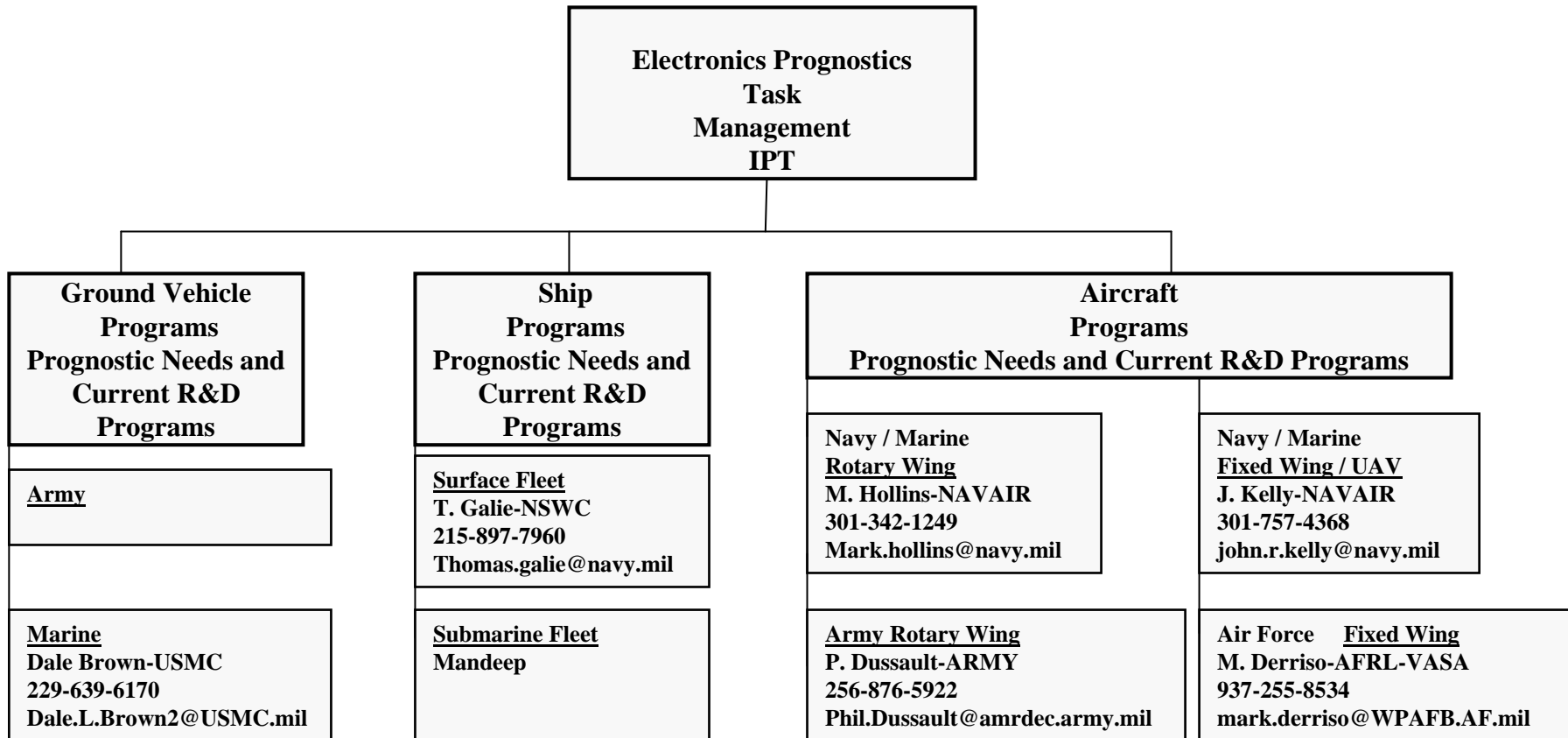
**3.9.2.4. The DoD Components shall initiate system modifications, as necessary, to improve performance and reduce ownership costs.**

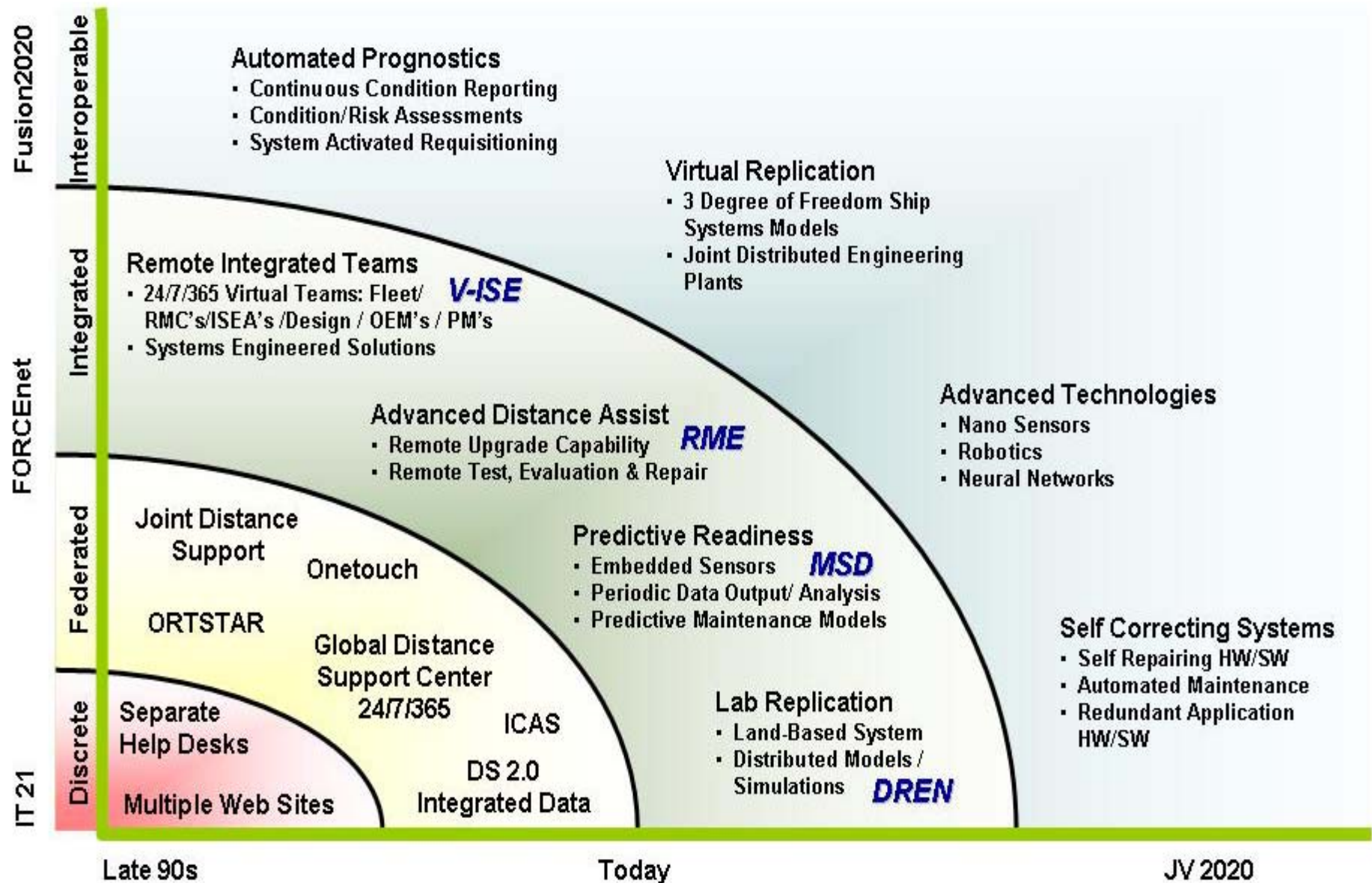
**3.9.2.4.1. PMs shall optimize operational readiness through affordable, integrated, embedded diagnostics and prognostics, and embedded training and testing; serialized item management; automatic identification technology (AIT); and iterative technology refreshment.**

## **Workshop II Objectives**

- **To identify the perceived needs of legacy and new weapon systems for electronic prognostics**
- **To identify common needs across multiple systems**
- **To draft the key content of S&T, RDT&E and V&V programs that address these common needs**
- **To assemble these programs into roadmaps for technology development**
- **To identify the follow-on issues to implement the roadmaps**

# Task Organization





# Navy Ship Panel

Panel Member	Topic Perspective	Sub Topic	Activity
Lynn Petersen	Science and Technology	High Power Systems	ONR
Professor O. A. Mohammed	Science and Technology	High Power Systems	Florida International University
CDR William R Graham	Fleet as a customer	Maintenance	FFC N434
LT Todd Jack	Fleet as a customer	C5IS&R Systems	FFC N65M/602
Joel Timm	Surface/Carrier Ship Systems	Combat	NSWC PHD
Dave Scheid	Surface/Carrier Ship Systems	Combat	NSWC PHD
Tom Perotti	Surface/Carrier Ship Systems	HM&E and LANs	NSWCCD Phila
Ernie Marvin	Submarines		NUSC Newport RI
Mark "Blaze" Blazejewski	DDX Design	Logisitics Support	Raytheon Naval Programs

## **Key Information Developed in Preparation for the Workshop**

- **Identification of key programs that can benefit from prognostics**
  - **System development programs**
  - **Existing Systems**
  - **Systems with planned upgrades**
- **Identification of key contacts in programs that are:**
  - **Willing to assist in collecting information needed for roadmap development**
  - **Available to present needs and participate in workshop**

## **Workshop II Tasks**

**To define the S&T, RDT&E and V&V efforts required for a broad spectrum of systems and to organize (combine) them into cross platform applicable R&D Roadmaps by:**

- **Defining weapon systems that can benefit from electronics prognostics by type (aircraft, ship, ground vehicles)**
- **Summarizing current available technologies, and on-going R&D efforts, and their state of development in terms of TRL.**
- **Define the S&T, RDT&E and V&V efforts required to bring these technologies to TRL 6-7 so that they can be confidently drawn upon by systems developers in their systems designs.**
- **Identify technology gaps and describe the S&T, RDT&E and V&V efforts to address them**
- **Analyze the information gathered and summarize it in Technology Roadmap form by type with the goal of defining common needs across the weapon system spectrum**

# Workshop Process Overview

## Day 1

- **Define needs by weapon system and application**
- **Assemble needs onto template**
  - **Prognostic need**
  - **Weapons system and application**
  - **Program elements to address need**
  - **Needs and development program timeline**

## Day 2

- **Integrate templates by application type**
- **Formulate template elements into activities:**
  - **S&T**
  - **RDT&E**
  - **V&V**
- **Translate template elements to roadmap**
- **Draft final report key points and recommendations**

# Workshop Agenda - 24 January 2006

<b>0700</b>	<b>Registration/Continental Buffet</b>	<b><u>Workshop Goal Accomplishment</u></b>
<b>0800</b>	<b>Plenary Session</b>	
	<ul style="list-style-type: none"> <li>• <b>NDIA ID Committee Introduction and Welcome</b></li> </ul>	<i>Importance</i>
	<ul style="list-style-type: none"> <li>• <b>Keynote – OSD Representative</b></li> </ul>	<i>Background</i>
	<ul style="list-style-type: none"> <li>• <b>Workshop Chair – Background, Tasks, Products, Layout</b></li> </ul>	<i>Resources</i>
	<ul style="list-style-type: none"> <li> <ul style="list-style-type: none"> <li>• <b>Resources – CALCE, SNL, Charge to Group</b></li> </ul> </li> </ul>	<i>Task Defined</i>
<b>1000</b>	<b>Break – 15 Min</b>	
<b>1015</b>	<b>Workshop Session A - Four Parallel Sessions</b>	<i>Needs by TA</i>
	<ul style="list-style-type: none"> <li>• <b>Ship Programs – T. Galie</b></li> </ul>	<i>Current R&amp;D</i>
	<ul style="list-style-type: none"> <li>• <b>Fixed Wing Aircraft Programs – J. Kelly, M. Derriso</b></li> </ul>	<i>S&amp;T Programs</i>
	<ul style="list-style-type: none"> <li>• <b>Rotary Wing Aircraft Programs – M. Hollins, S. Crews</b></li> </ul>	<i>RDT&amp;E Programs</i>
	<ul style="list-style-type: none"> <li>• <b>Ground Vehicle Programs – D. Brown</b></li> </ul>	<i>V&amp;V Programs</i>
<b>1215</b>	<b>Lunch – Speaker - Logistics Impact of Electronic Prognostics</b>	
<b>1330</b>	<b>Common Session – Tech. Area Session Leaders Present Results and Discussions</b>	
<b>1530</b>	<b>Break</b>	<i>Review of Workshop</i>
<b>1545</b>	<b>Common Session – Tech Area Sessions Present Results and Discussions</b>	<i>Day 1 Results</i>
<b>1700</b>	<b>Reception</b>	

## **24 January 2006 Breakout Session Format**

- **Needs Development Process**
- **Weapon System Programs Included and Basic Description (Scope)**
- **Applicable Current R&D**
- **Templates - Needs by Individual Application on Programs**
- **Group Discussion of Templates and Template Updates**
- **Preparation of Summary Presentation**
- **Identification of representatives to day 2 sessions**

## Completed Sample E-Prog Template

<b>Weapon System and Application</b>	CVN-21 - EMALS
<b>E-Prog Need Details</b>	<ul style="list-style-type: none"> <li>•Power electronics prognostics –24 hours / 70% confidence</li> </ul>
<b>Development Program Elements</b>	<ul style="list-style-type: none"> <li>•S&amp;T – sensing/detection techniques – failure models –Prognostics algorithms</li> <li>•RDT&amp;E – demonstration on military system</li> <li>•V&amp;V – Field Testing and Evaluation</li> </ul>
<b>Current S&amp;T, RDT&amp;E and V&amp;V Applicability</b>	<ul style="list-style-type: none"> <li>•Electronic carrier migration models</li> </ul>
<b>S&amp;T, RDT&amp;E and V&amp;V Needs and Development Program Timelines</b>	<ul style="list-style-type: none"> <li>•IOC 2011</li> <li>•Development Program Through V&amp;V 4 years</li> </ul>

## Workshop Agenda - 25 January 2006

	<u><i>Workshop Goal</i></u>	<u><i>Accomplishment</i></u>
0700 Registration and Continental Breakfast		
0800 Day 2 Charge and K. Gross – Sun Micro		
0830 Parallel Sessions to Consolidate Needs		
• Current R&D Applicability	<i>Develop Roadmaps</i>	
• S&T Program Needs - T. Galie	<i>Consolidate Roadmaps</i>	
• RDT&E Program Needs - J. Kelly, M. Hollins	<i>Program Elements</i>	
• V&V Program Needs - P. Dussault, C. Wenrick		
1000 Break		
1030 Roadmap Key Program Layout and Presentation Preparation	<i>Layout Roadmaps</i>	
1230 Lunch		
1330 Summarize Workshop Results	<i>Summarize Results</i>	
• Identify Key Issues	<i>Establish Product Schedules</i>	
• Next Steps for IPT to Address		
• Roadmap Completion Schedule		
• Final Report Development Schedule		
1530 Adjourn		

## **January 25<sup>th</sup> Session Format**

**4 parallel sessions covering specific topics with a mix of people from day 1 sessions**

**Goal is to have representation from all day 1 sessions in each day 2 session**

- **Session 1 - Current R&D applicability**
- **Session 2 - S&T Program Needs**
- **Session 3 - RDT&E Program Needs**
- **Session 4 - V&V Program needs**
- **Results will then be integrated at afternoon sessions**

## **Post Workshop II Tasks to Complete Effort**

- **Format workshop results into actionable plan and investment roadmap**
- **Establish funding sources, transition paths and sponsors**
- **Implement an Electronic System Prognostic - Implementation Initiative (ESP-I<sup>2</sup>)**
- **Prepare and deliver workshop final report**

## Backup Viewgraphs

**Integrated Diagnostics Committee  
June 2004 Electronics Prognostics Workshop  
Final Report Briefing**

**For The**

**NDIA Systems Engineering Conference  
October 2004**

ID Committee Co-Chairs

Howard Savage

Dennis Hecht

Report Author - Paul L. Howard

## **Goals of the Final Report**

- Review the Prognostic Definition and Terms of Reference Applied to the Workshop
- Summarize the ID Electronic Prognostics Workshop
- Define the Key Results / Conclusions from the Workshop
- Address the Tasking Question
- Integrate Comments / Recommendations from the Attendees and the ID Committee
- Recommend “Next Steps”
- Provide the NDIA ID Committee Response to the NAVAIR Tasking

# Prognostics Definition and Terms of Reference

- **PROGNOSTICS** - **A “FORECAST OF FUTURE PERFORMANCE AND / OR CONDITION”.**
- **Prognostic Accuracy or Confidence Level** – the accuracy in terms of difference between the future forecast of performance or condition and the actual future value achieved expressed as +/- an amount or as a percentage of the forecast. It may also be applied to the accuracy of the predicted time to failure, time to a given performance degradation point or percentage, remaining useful life, etc.
- **Prognostic Horizon** – the maximum time or related parameter (such as number of missions, etc.) for which a given Prognostic Technique will achieve a set accuracy or confidence level. For example, technique “A” may achieve a 90% prognostic accuracy with a horizon of 200 operating hours, or Prognostic Technique “B” may achieve a 75% prognostic accuracy with a prognostic horizon of 3 missions.
- **Prognostic Metrics** – those measures of performance of a prognostic technique or system that characterize the performance and predictive reliability of that technique or system for a specific application. These metrics may include:
  - Demonstrated versus design prognostic accuracy / confidence level.
  - Demonstrated versus design prognostic horizon.
  - Demonstrated reliability of the prognostic system versus the system it monitors.
  - Applicability or robustness of the prognostic technique or system – how many other applications can the technique be applied to with commensurate accuracy, reliability and horizon attributes.

## **NAVAIR Tasking**

“Identify the types of diagnostic data that should be collected for use in providing an electronic systems prognostic capability”

Requested by:

John Kelly

USNCIV NAVAIR 2133

# **Key Points From the Three Workshop Sessions**

- Electronic Prognostics Requirements –The need for prognostics on electronic systems is common to many current and new weapon system programs. As electronic systems start to represent higher percentages of weapon system content, the urgency of addressing this issue increases.
- Current Electronic Prognostic Applications & Tools – There is a baseline set of tools and practices that are currently available and/or in use for prognostics of certain specific types of electronic systems. Some models as well as tools for modeling and data mining for electronic systems exist and are being applied. Additionally, since many of the electronic failure modes may actually be due to or caused by mechanical failure mechanisms (solder joint failures, PC Board trace breakage, contact corrosion, etc.) it may be prudent to adapt already proven mechanical system prognostic technology to some electronic system prognostic applications.
- Current Electronic Prognostic Research and Development Activities – There are emerging tools and technologies that, when developed, may augment the baseline technology, including the application of nonlinear analytical techniques to detect early onset of faults. One current focus is Power Supply prognostics in currently active JSF sponsored SBIRs, including the use of actual loadings and failure physics to predict solder joint crack initiation and device failure and the potential for tracking BIT “false indications” as potential early indicators of the onset of faults.

## **ID Committee Actions**

- **Review and Approval of the Final Report - Completed**
- **Forward to the NDIA SE Division as the ID Committee Response to the NAVAIR Tasking - Completed**
- **NDIA SE Division Approval to Act on Recommendations - Completed**
- **Establish Task Group to Act on the Recommendations - In Process - Chaired by Jim Dill ( ID Committee)**